

# DEEP IMPACT

## FIRST LOOK INSIDE A COMET!

<http://deepimpact.jpl.nasa.gov>

<http://deepimpact.umd.edu>

### What's deep inside a comet?

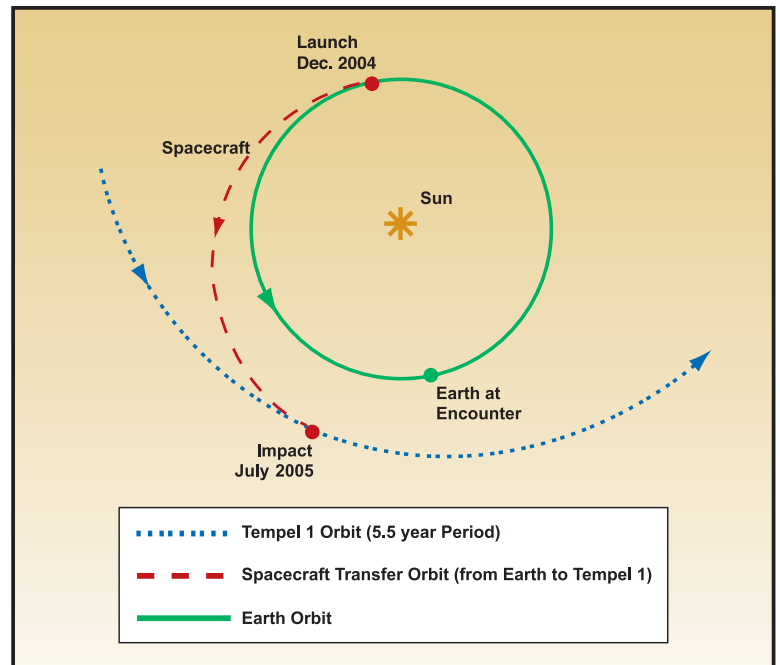
Comets are time capsules that hold clues about the formation and evolution of the solar system. They are composed of ice, gas and dust, primitive debris from the solar system's distant and coldest regions that formed 4.5 billion years ago. Deep Impact, a NASA Discovery Mission, is the first space mission to probe beneath the surface of a comet and reveal the secrets of its interior.

On July 4, 2005, the Deep Impact spacecraft arrives at Comet Tempel 1 to impact it with a 370-kg (~820-lbs) mass. On impact, the crater produced is expected to range in size from that of a house to that of a football stadium, and two to fourteen stories deep. Ice and dust debris is ejected from the crater revealing fresh material beneath. Sunlight reflecting off the ejected material provides a dramatic brightening that fades slowly as the debris dissipates into space or falls back onto the comet. Images from cameras and a spectrometer are sent to Earth covering the approach, the impact and its aftermath. The effects of the collision with the comet will also be observable from certain locations on Earth and in some cases with smaller telescopes. The data is analyzed and combined with that of other NASA and international comet missions. Results from these missions will lead to a better understanding of both the solar system's formation and implications of comets colliding with Earth.

### The Mission

The Deep Impact mission lasts six years from start to finish. Planning and design for the mission took place from November 1999 through May 2001. The mission team is proceeding with the building and testing of the two-part spacecraft. The larger "flyby" spacecraft carries a smaller "impactor" spacecraft to Tempel 1 and releases it into the comet's path for a planned collision.

In December 2004, a Delta II rocket launches the combined Deep Impact spacecraft which leaves Earth's orbit and is directed toward the comet. The combined spacecraft approaches Tempel 1 and collects images of the comet before the impact. In early July 2005, 24 hours before impact, the flyby spacecraft points high-precision tracking telescopes at the comet and releases the impactor on a course to hit the comet's sunlit side.



*Deep Impact's orbital path to encounter Comet Tempel 1.*



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## The Mission (continued)

The impactor is a battery-powered spacecraft that operates independently of the flyby spacecraft for just one day. It is called a "smart" impactor because, after its release, it takes over its own navigation and maneuvers into the path of the comet. A camera on the impactor captures and relays images of the comet's nucleus just seconds before collision. The impact is not forceful enough to make an appreciable change in the comet's orbital path around the Sun.

After release of the impactor, the flyby spacecraft maneuvers to a new path that, at closest approach passes 500 km (300 miles) from the comet. The flyby spacecraft observes and records the impact, the ejected material blasted from the crater, and the structure and composition of the crater's interior. After its shields protect it from the comet's dust tail passing overhead, the flyby spacecraft turns to look at the comet again. The flyby spacecraft takes additional data from the other side of the nucleus and observes changes in the comet's activity. While the flyby spacecraft and impactor do their jobs, professional and amateur astronomers at both large and small telescopes on Earth observe the impact and its aftermath, and results are broadcast over the Internet.

## Comet Tempel 1

Comet Tempel 1 was discovered in 1867 by Ernst Tempel. The comet has made many passages through the inner solar system orbiting the Sun every 5.5 years. This makes Tempel 1 a good target to study evolutionary change in the mantle, or upper crust. Comets are visible for two reasons. First, dust driven from a comet's nucleus reflects sunlight as it travels through space. Second, certain gases in the comet's coma, stimulated by the Sun, give off light like a fluorescent bulb. Over time, a comet may become less active or even dormant. Scientists are eager to learn whether comets exhaust their supply of gas and dust to space or seal it into their interiors. They would also like to learn about the structure of a comet's interior and how it is different from its surface. The controlled cratering experiment of this mission provides answers to these questions.

## Technical Implementation

The flyby spacecraft carries a set of instruments and the smart impactor. Two instruments on the flyby spacecraft observe the impact, crater and debris with optical imaging and infrared spectral mapping. The flyby spacecraft uses an X-band radio antenna (transmission at about eight gigahertz) to communicate to Earth as it also listens to the impactor on a different frequency. For most of the mission, the flyby spacecraft communicates through the 34-meter antennae of NASA's Deep Space Network. During the short period of encounter and impact, when there is an increase in volume of data, overlapping antennas around the world are used. Primary data is transmitted immediately and other data is transmitted over the following week. The impactor spacecraft is composed mainly of copper, which is not expected to appear in data from a comet's composition. For its short period of operation, the impactor uses simpler versions of the flyby spacecraft's hardware and software - and fewer backup systems.

## The Team

The Deep Impact mission is a partnership among the University of Maryland (UMD), the California Institute of Technology's Jet Propulsion Laboratory (JPL) and Ball Aerospace and Technology Corp. The scientific leadership of the mission is based at UMD. Engineers at Ball Aerospace design and build the spacecraft under JPL's management. Engineers at JPL control the spacecraft after launch and relay data to scientists for analysis. The entire team consists of more than 250 scientists, engineers, managers, and educators. Deep Impact is a NASA Discovery Mission, eighth in a series of low-cost, highly focused space science investigations. Deep Impact offers an extensive outreach program in partnership with other comet and asteroid missions and institutions to benefit the public, educational and scientific communities.